

CLAIMS:

1 A switchable optical element having a first discrete state and a different, second discrete state, the element comprising:

- a) a fluid system including a first fluid and a different, second fluid;
- b) a wavefront modifier having a face; and
- c) a fluid system switch for acting on the fluid system to switch between

the first and second discrete states of the element,

wherein, when the element is in the first discrete state, the face of the wavefront modifier is substantially covered by the first fluid, and

10 when the element is in the second discrete state, the face of the wavefront modifier is substantially covered by the second fluid,

characterized in that said fluid system switch comprises:

a configuration of electrodes arranged to act on the fluid system by the application of electrowetting forces; and

15 a voltage control system arranged to control voltages applied to the configuration of electrodes to switch between the first and second discrete states of the element.

2. A switchable optical element according to claim 1, wherein the first fluid is electrically conductive and the second fluid is electrically insulative.

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3. A switchable optical element according to claim 2, wherein the first fluid and the second fluid are both liquids.

4. A switchable optical element according to any preceding claim, wherein the configuration of electrodes includes a first electrode having an operative area, and wherein
25 the face of the wavefront modifier and the operative area of the first electrode are arranged in a substantially overlapping arrangement.

5. A switchable optical element according to any preceding claim, wherein the configuration of electrodes includes a first electrode, a second electrode, and a common, third electrode,

the voltage control system being arranged to apply voltages differently to the first and second electrodes in at least one of the first and the second discrete states of the element.

6. A switchable optical element according to any preceding claim, comprising:
a chamber in which the face of the wavefront modifier is located, and
a conduit, the conduit having two ends, each end being fluidly connected to the chamber at a separate location,

wherein the element is arranged such that, during a transition between the first and second discrete states of the element, circulatory fluid flow occurs so that fluid passes from the chamber into the conduit via one of the said two ends and fluid passes from the conduit into the chamber via the other of the said two ends.

7. A switchable optical element according to any preceding claim, wherein the face of the wavefront modifier comprises one or more protrusions, the protrusions being arranged to provide a predetermined wavefront modification on a given radiation beam of predetermined wavelength when the element is in one of said first and second discrete states.

8. A switchable optical element according to claim 7, wherein the protrusions are arranged concentrically about an optical axis.

9. A switchable optical element according to claim 7, wherein the protrusions are linear and arranged parallel each other.

10. A switchable optical element according to claim 7, 8 or 9, wherein the protrusions form a diffraction grating.

11. A switchable optical element according to claim 7, 8 or 9, wherein the protrusions form a non-periodic stepped profile in a direction transverse to said face.

12. A switchable optical element according to any preceding claim, comprising:

a second wavefront modifier face, the element having third and fourth discrete states associated with the second face, and

a second fluid system including a third fluid and a different, fourth fluid,

wherein, when the element is in the third discrete state the second face is

5 substantially covered by the third fluid, and

when the element is in the fourth discrete state, the second face is substantially covered by the fourth fluid,

wherein the voltage control system is arranged to control voltages applied to the configuration of electrodes to switch between the third and fourth discrete states of the
10 element.

13. A switchable optical element according to any preceding claim, wherein the wavefront modifier comprises a birefringent material.

15 14. A switchable optical element according to any preceding claim, wherein the first and/or second fluid comprises a liquid crystal material.

15. An optical scanning device for scanning an information layer, the device comprising a switchable optical element according to any preceding claim, said optical
20 scanning device comprising:

a) a radiation source system for emitting a first radiation beam of a first predetermined wavelength and a second radiation beam of a second predetermined wavelength; and

b) an objective lens system for converging the radiation beams on
25 respective information layers,

wherein a first predetermined wavefront modification is provided on the first radiation beam when the element is in the first discrete state, and

a second predetermined wavefront modification element is provided on the second radiation beam when the element is in the second discrete state.

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16. An optical scanning device according to claim 15, wherein the first predetermined wavefront modification at least approximates spherical aberration and/or defocus.

17. An optical scanning device according to claim 15 or 16, wherein the second predetermined wavefront modification is at least approximately flat.

5 18. An optical scanning device according to claim 15, wherein the radiation source system is adapted to emit a third radiation beam of a third predetermined wavelength, wherein a third predetermined wavefront modification is provided on the third radiation beam when the element is in the second state.

10 19. An optical scanning device according to claim 18, wherein the third predetermined wavefront modification is either at least approximately flat, or at least approximates spherical aberration and/or defocus.